

New records of *Megaselia* (Diptera: Phoridae)
reared from fungus sporophores in Japan,
including five new species

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1 1 **New records of *Megaselia* (Diptera: Phoridae) reared from fungus**
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3 2 **sporophores in Japan, including five new species**
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29 13 **Abstract**
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31 14 *Megaselia donaldsonae* Disney sp. nov., *M. flava* (Fallén), *M. gotoi* Disney, *M.*
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33 15 *kanekoi* Disney, *M. margaretae* Disney sp. nov., *M. nakayamai* Disney sp. nov.,
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35 16 *M. salteri* Disney sp. nov. and *M. stepheni* Disney sp. nov. were reared from
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37 17 sporophores of fungi.
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43 19 **Key words:** mycophagy, *Amanita*, *Gymnopilus*, *Russula*
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48 21 **Introduction**
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51 22 Most of the reports of scuttle flies (Diptera, Phoridae) reared from fungi are from
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53 23 sporophores in Europe, but include a few records from Japan (Disney, 1994).
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55 24 The majority of these records are for species of the giant genus *Megaselia*
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57 25 Rondani (Disney 1994). But these records represent a subset only of the
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known larval habits for this genus, which includes parasitoids, predators, feeders on decaying organic materials, etc (Disney 1994). Species reared from fungi are a substantial subset that includes true fungus feeders but also some known to be parasitoids of the larvae of other fungus feeders (e.g. Sciaridae). *Megaselia*" is one of the largest, most biologically diverse and taxonomically difficult genera in the entire animal kingdom" (Marshall 2012). Our knowledge of Japanese species of *Megaselia* is rudimentary. Prior to this study the total was 23 described species (Disney 1989a). By contrast at least 250 species are recorded from the British Isles (Disney 1989b, and subsequent additions) and at least 1500 species for the world (according to Henry Disney's most recent estimate). Our knowledge of Japanese species associated with fungi is likewise in its infancy. This paper extends our knowledge.

During 2012, Masayuki Nitta and Mio Kobayashi, under the supervision of Nobuko Tuno, reared insects from fungi sporophores. The scuttle flies were kindly examined by Dr. Hiroto Nakayama (Biosystematics Laboratory, Graduate School of Social & Cultural Studies, Kyushu University). He reported that they all belonged to the huge genus *Megaselia*, with three being of previously reported species from Japan but the rest being undescribed species. The latter were sent to Henry Disney who describes five new species below.

Materials and methods

Sporophores of fungi were collected and put on moist vermiculite in containers of appropriate sizes at 27±1°C under 14 hour light and 10 hour dark photoperiod

conditions. The containers lids had a hole plugged with cotton wool to ensure adequate air exchange. The sporophores were misted with water to maintain adequately high humidity. The containers were checked for emerging insects every 1 or 2 days for at least one month after sporophore collection.

The flies that emerged were preserved in 70% ethanol. Some were mounted whole on slides in Berlese Fluid and the rest sent to Henry Disney. He made slide mounts of specimens dissected into components placed under separate coverslips (e.g. Disney 1983) mounted in the same medium, whose advantages have been discussed elsewhere (Disney 2001).

The holotypes and some paratypes of the new species are deposited in the Museum of Zoology of the University of Cambridge (MZUC). Some paratypes are deposited in the Laboratory of Ecology of Kanazawa University (LEKU). The sample numbers refer to the rearing records. The reference numbers (e.g. 34–166) are also written on the slide labels and refer to Henry Disney's notebook 34 and page 166. In this study, we applied updated fungal supra-genetic classifications (Hosaka *et al.* 2011), however, we employed sporophore names as reported in the previous studies (Disney 1994).

Results

The following species of scuttle flies were reared from the fungi indicated. ***Megaselia donaldsonae* Disney sp. nov.** (Fig. 1A–F)

Etymology. Named for Margaret Donaldson (see Acknowledgements).
Type series. Holotype, male, Ishikawa Prefecture, Kanazawa City, 9_20 vii
 2012, ex *Amanita vaginata* (Amanitaceae), N. Tuno (sample 21, MZUC, 34–
 166). Paratypes: 4 males, 5 females same data as holotype except females
 (sample 22, MZUC, 34-167); and 1 male, 2 females (samples 15–17, LEKU).
Diagnosis. The fifth segment of the mid tarsus being clearly longer than the
 fourth segment means that in the key to males recorded from the British Isles
 (Disney 1989a) this species runs to couplet 12, lead 2, to *M. lutea* (Meigen);
 from which it is at once distinguished by its hairs on the mesopleuron (e.g. as fig.
 8.3(a) in Disney 1994). In the keys to Australasian and Oriental species
 (Borgmeier 1967) it will run to couplet 11 on page 206. As its costal index is
 intermediate between the two options offered it needs to be keyed both ways.
 However, the male is immediately distinguished from all the species of the
 following couplets by the same mid tarsal feature indicated above. Likewise
 several subsequently described species are excluded with the exception of two
 species from China, from which it is distinguished in the key below.
Description. Male. Frons mainly yellow but brown around the sockets of the
 supra-antennal bristles (SAs) and ocelli, clearly broader than long, with 42_54
 hairs and dense but very fine microtrichia. Supra-antennal bristles unequal (Fig.
 1A), the lower pair being at most two thirds as long as upper pair. The antials
 lower on frons than anterolaterals (ALs), and about midway between upper SAs
 and an AL bristle. Pre-ocellars a little nearer together than either from a
 mediolateral bristle, all four being at about the same level on frons. Cheek with
 4_5 bristles and jowl with 2 long and 1 shorter bristles. The subglobose

98 postpedicels yellow, without subcutaneous pit sensilla (SPS) vesicles (Fig. 1A).
 99 Palps (Fig. 1A) yellow, about 1.5 times as long as breadth of postpedicel, with 5
 100 bristles, the longest (apical) being about as long as lower SAs, and 5–8 hairs.
 101 Labrum (Fig. 1A) slightly darker than palps and about 0.8–0.9 times as wide as
 102 a palp. Labella (Fig. 1A) coloured as palps and with only a few short spinules
 103 below. Thorax, apart from brown patch on pteropleuron, yellow. Three
 104 notopleural bristles, the middle one being shorter than the other two, and no
 105 cleft in front of these. Mesopleuron with 4–7 (most commonly 5–6) hairs.
 106 Scutellum with an anterior pair of hairs (about as long as those in middle of
 107 scutum) and a posterior pair of bristles. Abdominal tergites 1–4 brown
 108 contrasting with yellow tergites 5–6 and with hairs, those towards the sides of
 109 tergite 2 and at rear of tergite 6 being longer than the rest (Fig. 1B). Venter
 110 yellow with hairs on segments 3–6. Hypopygium with brown epandrium with a
 111 pale yellow anal tube (Fig. 1B), the epandrium with moderately long hairs only
 112 and thus lacking differentiated bristles. Hypandrium largely dusky yellow, with a
 113 pair of asymmetric lobes; left lobe large, with small microtrichia and with few
 114 beyond the basal half; right lobe much shorter and smaller, with stronger
 115 microtrichia extending its full length. The pair of hypandrial hairs short but
 116 somewhat robust. Apart from brown patch on mid coxa, legs yellow. Fore
 117 tarsus with posterodorsal hair palisade on segments 1–5; segment 5 longer than
 118 4. The ratios of the lengths of tarsal segments about 3.6: 1.1: 1.0: 0.8: 1.
 119 Dorsal hair palisade of mid tibia extending about three quarters and its spur
 120 about 0.8 times as long as basitarsus. The ratios of the lengths of mid tarsal
 121 segments (Fig. 1C) about 2.1: 1.1: 0.9: 0.4: 1. Hairs below basal half of hind

122 femur clearly longer than those of anteroventral row of outer half. Hind tibia
 123 with 12_16 differentiated posterodorsal hairs and simple spinules of apical
 124 combs. Wings (Fig. 1D) 1.8_1.9 mm long. Costal index 0.45_0.52. Costal
 125 ratios 4.3_5.0: 1.6_1.9: 1. Costal cilia (of section3) 0.07_0.08 mm long. No hair
 126 at base of vein 3. Sc not reaching vein 1. With 2 axillary bristles, both being
 127 longer than costal cilia (the outer one being 0.12_0.15 mm long). Sc almost
 128 reaching R1. Thick veins yellowish gray; thin veins gray but pale. Membrane
 129 tinged gray (evident to naked eye when viewed against a white background).
 130 Haltere grayish brown.

131 Female. Head similar to male except labrum 1.3_1.4 times as wide as diameter
 132 of postpedicel and palps with 5_7 bristles and at least as many hairs. Thorax,
 133 apart from brown patch on pteropleuron, yellow as male. Abdominal tergites
 134 yellow. Tergites 5–6 with hairs (Fig. 1E). Venter yellow, with hairs below
 135 segments 3–6. Sternite 7 pale (Fig. 1F). Posterolateral lobes at rear of sternum
 136 8 not long and with hairs at base. Cerci very pale and about 2.5 times as long
 137 as broad. Furca not evident. Dufour's crop mechanism about 2.3 times as long
 138 as greatest width and rounded behind. Legs ratios of the lengths of mid tarsal
 139 segments about 3.7: 1.8: 1.6: 0.8: 1. Wing length 2.0_2.1 mm. Costal index
 140 0.48_0.54. Costal ratios 5.0_5.9: 1.7_2.4: 1. Haltere grayish brown.

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142 ***Megaselia flava* (Fallén)**

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144 *Trineura flava* Fallén, 1823: 7.

145 *Aphiochaeta matsutakei* Sasaki, 1935: 112.

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147 *Material examined.* A hundred fifty specimens emerged from the sporocarps of

148 the following species belonging to 3 orders (Agaricales, Boletales, and

149 Russulales) in Ishikawa Prefecture: *Agaricus abruptibulbus*, *Calvatia*

150 *craniiformis*, *Chlorophyllum neomastoideum* (Agaricaceae), *Amanita*

151 *ibotengutake*, *A. longistriata*, *A. pantherina*, *A. pseudoporphyria*, *A. punctata*, *A.*

152 *spissacea*, *A. sychnopyraxis*, *A. vaginata*, *A. virgineoides*, *Amanita* sp.

153 (Amanitaceae), *Hygrocybe cuspidate* (Hygrophoraceae), *Gymnopus peronatus*

154 (Omphalotaceae), *Armillaria tabescens* (Physalacriaceae), *Psilocybe*

155 *argentipes* (Strophariaceae), *Boletellus floriformis*, *B. bicolor*, *B. griseus*,

156 *Heimioporus japonicus*, *Leccinum eximium*, *Tylopilus neofelleus*, *T. rigens*, *T.*

157 *vinosobrunneus*, *Xanthoconium affine*, *Xerocomus subtomentosus* (Boletaceae),

158 *Suillus bovinus* (Suillaceae), *Russula alboareolata*, *R. cyanoxantha*

159 (Russulaceae).

160 This species has previously been reared from the sporophores of the

161 following fungi, *Amanita ibotengutake* (Yamashita *et al.* 2005) and *A. muscaria*

162 (Yakovlev 1986, 1994) (Amanitaceae), *Boletus rubellus* (Khalidov 1984;

163 Yakovlev 1994), *Leccinum scabrum* aggregate (Yakovlev 1986) (Boletaceae),

164 *Gymnopilus hybridus* (Disney & Evans 1988) (Cortinariaceae), *Armillaria*

165 *matsudake* (Sasaki 1935; Kiyoku 1958) and *A. mellea* (Yakovlev 1994)

166 (Marasmiaceae), *Peziza* (= *Aleuria*) sp. (Yakovlev 1980, 1986), *P. micropus*

167 (Disney & Evans 1982; Disney & Ševčík 2009), *P. repanda* (Colyer 1954;

168 Buxton 1961; Disney 1994), *P. varia* (Disney & Evans 1982, 1999), and *P.*

169 *vesiculosa* (Disney & Evans 1996) (Pezizaceae), *Pluteus cervinus* (=

atricapillus) (Disney & Evans 1982) (Pluteaceae), *Russula aeruginea* (Eisfelder 1956), *R. heterophylla* (Schmitz 1948), *R. risigallina* form *roseipes* (Yakovlev 1994), *R. rubra* (Schmitz 1948) and *R. violeipes* (Ševčík 2001) (Russulaceae), *Suillus granulatus* (Yakovlev 1994) (Suillaceae), and *Tricholoma matsutake* (= *T. edodes*) (Sasaki 1935; Kiyoku 1958) (Tricholomataceae). The larvae invade the stems of the sporophores.

***Megaselia gotoi* Disney**

Megaselia gotoi Disney, 370.

Material examined. Twenty-one specimens were reared from sporophores of the following species belonging to two orders, Agaricales and Russulales; *Amanita castanopsidis*, *A. hemibapha*, *A. neoovoidea*, *A. punctata*, *A. sychnopyramis*, *A. virosa*, *Amanita* sp. (Amanitaceae), *Hymenopellis* sp. (Physalacriaceae), *Russula cyanoxantha*, *Russula* sp. (Russulaceae).

The species has previously been reared from sporophores of *Amanita farinosa* and *A. spissacea* (Disney 1989b) and *A. ibotengutake* (Yamashita et al. 2005).

***Megaselia kanekoi* Disney**

Megaselia kanekoi Disney 1989b, 372.

193 *Material examined.* Eight specimens were reared from sporophores of the
194 following species belonging to Agaricales and Russulales. *Amanita*
195 *pseudoporphyrina* (Amanitaceae), *Hymenopellis* sp. (Physalacriaceae), *Russula*
196 *alboareolata*, *R. cyanoxantha*, *Russula* sp. (Russulaceae).

197 The species has previously been reared from sporophores of *Amanita*
198 *spissacea* (Disney 1989b) and *A. ibotengutake* (Yamashita *et al.* 2005).

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200 ***Megaselia margaretae* Disney sp. nov.** (Fig. 2A–H)

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202 *Etymology.* Named for Margaret Donaldson (see Acknowledgements).

203 *Type series.* Holotype, male, Ishikawa Prefecture, Kanazawa City, 9–20 vii

204 2012, ex *Amanita vaginata* (Amanitaceae) (sample 23, MZUC, 34–167).

205 Paratypes: 1 male, 3 females same data as holotype except females (sample
206 24); 4 males Ishikawa Prefecture, Nomi City, 4–18.ix.2012, ex *A.*

207 *pseudoporphyrina* (sample 20, MZUC, 34–166, samples 8 & 9, LEKU); 3 males,

208 2 females, Ishikawa Prefecture, Nanao City, 22.vii–4.viii.2012, ex *Amanita* sp.,

209 *N. Tuno* (samples 10–14, LEKU); 2 females, Kanazawa City, 2–15.vii.2012, ex

210 *Russula violeipes*, *N. Tuno* (samples 6 & 7, LEKU).

211 *Diagnosis.* The fifth segment of the mid tarsus clearly longer than the fourth

212 segment means that in the key to males recorded from the British Isles (Disney

213 1989a) this species runs to couplet 12, lead 2, to *M. lutea* (Meigen); but more

214 closely resembles the Japanese *M. gotoi* and an Australasian and an Oriental

215 species. It is distinguished from these 3 species in the key below.

Description. Male. Frons mainly yellow but brown around sockets of the Supra-
antennal bristles (SAs) and ocellar triangle, with 28_44 hairs and dense but very
fine microtrichia. Supra-antennal bristles unequal, the lower pair being about
half as long as the upper pair. The antials a little lower on frons than
anterolaterals (which slightly higher on frons than upper SAs), and 3_6 times as
far from upper SAs as either from an AL bristle. Pre-ocellars slightly further
apart than either from a mediolateral bristle, which very slightly higher on frons.
Cheek with 2_3 bristles and jowl with 2. Postpedicels subglobose, yellow,
without subcutaneous pit sensilla (SPS) vesicles (Fig. 2A). Palps (Fig. 2A)
yellow, 1.3_1.5 times as long as postpedicel, with 6 bristles, the most apical
being about half as long as palp, and up to twice as many hairs. Labrum (Fig.
2A) yellow and about 0.8_0.9 times as wide as a postpedicel. Labella (Fig. 2A)
yellow, at most with only 1_2 hairs reduced to short spinules below. Thorax
mainly yellow, with 3 notopleural bristles and no cleft in front of these.
Mesopleuron bare. Scutellum with an anterior pair of hairs (as long as those in
middle of scutum) and a posterior pair of bristles. Abdominal tergites 1–3
extensively brown (especially tergite 3) and tergites 4–6 mainly yellow, slightly
longer hairs towards the sides of tergite 2 and at rear of tergite 6 (Fig. 2B).
Venter yellow, and with hairs on segments 3–6 (Fig. 2B). Hypopygium with
brown epandrium, the hypandrium largely pale dusky yellow, with a pale yellow
anal tube (Fig. 2B). Apart from brown patch on mid coxa, legs yellow. Fore
tarsus with posterodorsal hair palisade on segments 1–5; 5 slightly longer than
4. The ratios of the lengths of the segments about 3.2: 1.5: 1.1: 0.6: 1; segment
5 slightly wider than 3 and 4. Dorsal hair palisade of mid tibia extends about

1 240 0.8 times its length and its apical spur about 0.8_0.9 times as long as mid
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3 241 basitarsus (Fig. 2C) and rest of mid tarsus as Fig. 2C. Hairs below basal half of
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5 242 hind femur longer than those of anteroventral row of outer half (Fig. 2D). Hind
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7 243 tibia with 16_18 differentiated posterodorsal hairs and spinules of apical combs
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9 244 simple. Wings (Fig. 2E) 1.2_1.9 mm long. Costal index 0.48_0.52. Costal ratios
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11 245 6.7_8.0: 2.9_4.4: 1. Costal cilia (of section 3) 0.05_0.07 mm long. No hair at
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13 246 base of vein 3. With 2 axillary bristles, both being longer than costal cilia (the
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15 247 outer being 0.09_0.12 mm long). Sc not reaching R1. Thick veins brown but
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17 248 costa paler than rest, thin veins brown but pale. Membrane tinged grey (just
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19 249 evident to naked eye when viewed against a white background). Haltere
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21 250 brown.
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28 251 Female. Head (Fig. 2F) similar to male but labrum about 1.1 times wider than
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30 252 diameter of postpedicel. Thorax mainly yellow as male. Abdominal tergites 2–6
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32 253 typically with anterior two thirds yellow and posterior third brown, but the brown
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34 254 reduced on tergites 5–6. Tergites 5–6 as Fig. 2G, tergite 6 being slightly wider
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36 255 at its anterior end than its greatest length; and the sub rectangular tergite 7 (Fig.
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38 256 2G) almost 3 times as long as its greatest breadth and the hairs restricted to the
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40 257 posterior two fifths. Venter yellow but a little greyer on the flanks below the
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42 258 sides of the tergites, with hairs below segments 3–6, but those on 3 reduced to
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44 259 only 1 or 2. Sternite 7 (Fig. 2H) at least twice as long as greatest breadth and
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46 260 tapered forwards in its anterior half and with its hairs restricted to its posterior
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48 261 half. Posterolateral lobes at rear of sternum 8 pale (Fig. 2H), at least as long as
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50 262 width at base and with 3 longer bristles behind and 2 smaller ones in front.
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52 263 Cerci pale and at most 1.5 times as long as broad. Furca and Dufour's crop
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mechanism not discerned. Legs similar to male except segment 5 of the mid
tarsus is about as long as segment 4. Wing as in males except length 1.8–1.9
mm, Costal index 0.52–0.57. Costal ratios 5.4–6.3: 3.0–3.4: 1. Outer axillary
bristle 0.11–0.12 mm long. Costal cilia 0.07–0.08 mm long.

***Megaselia nakayamai* Disney sp. nov.** (Fig. 3A–C)

Etymology. Named for Dr. Hiroto Nakayama who identified specimens
belongings to described species.

Type series. Holotype, male, Ishikawa Prefecture, Nanao City, 22.vii–1
viii.2012, ex *Russula cyanoxantha* f. *peltereau* (Russulaceae), N. Tuno (sample
19, MZUC, 34–166).

Diagnosis. In the keys to the males of *Megaselia* species from the British Isles it
runs to couplet 267, lead 1, to *M. surdifrons* (Wood). The subsequently
described *M. okazakii* Disney also runs to this point. Both differ from *M.*
nakayamai in having thorax and postpedicels brown, a grayish venter with hairs
on segments 3–6, a pair of long bristles on the hypandrium, and with a small
hair at the base. In addition *M. okazakii* has a shortened dorsal face of the
epandrium and much paler wings.

Description. Male. Frons yellow but ocellar triangle largely brown, clearly
broader than long, with 90–96 hairs and dense but very fine microtrichia. Supra-
antennal bristles (SAs) unequal the lower pair being half as long as the upper
pair. The antials lower on frons than anterolaterals, and about 1.5 times as far
from upper SAs as either from an AL bristle. Pre-ocellars about as far apart as
either from a mediolateral bristle, which at about the same level on frons.

288 Cheek with seemingly no bristles and jowl with two. The subglobose
 289 postpedicels yellow, without subcutaneous pit sensilla (SPS) vesicles (Fig. 3A).
 290 Palps (Fig. 3A) yellow, about two fifths as broad as postpedicel but almost twice
 291 as long as breadth of latter, with 6 bristles, the longest (apical) being only about
 292 half as long as an upper SA bristle, and with as many hairs. Labrum obscured
 293 in available specimen. Labella almost as pale as palps, together at least twice
 294 as broad as postpedicel, and with numerous, densely crowded, short spinules
 295 below. Thorax yellow. Two notopleural bristles and no cleft in front of these.
 296 Mesopleuron bare. Scutellum with an anterior pair of hairs (about as long as
 297 those in middle of scutum) and a posterior pair of bristles. Abdominal tergites
 298 brown with hairs a little longer towards sides of tergite 2 and clearly longest at
 299 rear of tergite 6 (Fig. 3B). Venter very pale yellow, and with hairs only on
 300 segments 5 and 6. Hypopygium with light brown epandrium, a pale hypandrium
 301 with a pale yellow anal tube (Fig. 3B). Apart from brown patch on mid coxa,
 302 legs yellow. Fore tarsus with posterodorsal hair palisade on segments 1–4 and
 303 5 clearly longer than 4. Dorsal hair palisade of mid tibia extends almost three
 304 quarters of its length. Hairs below basal half of hind femur longer than those of
 305 anteroventral row of outer half. Hind tibia with 14–16 differentiated
 306 posterodorsal hairs and spinules of apical combs simple. Wings (Fig. 3C) 1.1–
 307 1.2 mm long. Costal index 0.54–0.55. Costal ratios 3.0–3.1: 1.9: 1. Costal cilia
 308 (of section 3) 0.04–0.05 mm long. No hair at base of vein 3. With 2 axillary
 309 bristles, both being longer than costal cilia (the outermost 0.09 mm long). Sc
 310 not reaching R1. Costa pale, rest of thick veins light brown, 4–6 grey and 7 very
 311 pale. Membrane only lightly tinged grey. Haltere with light gray knob.

312 ***Megaselia salteri* Disney sp. nov.** (Fig. 4A–G)

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314 *Etymology.* Named for Stephen Salter (see Acknowledgements).

315 *Type series.* Holotype, male, Ishikawa Prefecture, Nomi City, 12–27.vii.2012,

316 ex *Gymnopilus* sp. (family undetermined), N. Tuno (sample 28, MZUC, 34–

317 168). Paratypes: 3 females as holotype; 1 male, 6 females as holotype except

318 12–26.vii.2012 (samples 1 & 27, MZUC, samples 2–3, LEKU); 1 male, 6

319 females, Kanazawa City, 6–18.ix.2012, ex *G. picreus*, N. Tuno (sample 29,

320 MZUZ, 34–168).

321 *Diagnosis.* In the key to the males of *Megaselia* species from the British Isles it

322 runs to couplet 285, where the lack of a notopleural cleft and the AL bristles

323 being clearly higher on the frons than the antials excludes the two species of

324 this couplet. The hypopygium of the mainland European species *M. praeacuta*

325 (Schmitz) has a much shorter anal tube and hypandrial lobes, apart from its

326 postpedicels having SPS vesicles. The subsequently described *M.*

327 *tamilnaduensis* Disney will also run to this couplet but it has a distinctly different

328 hypopygium, with its shortened dorsal face of the epandrium and shorter anal

329 tube and shorter hairs below the basal half of the hind femur, and it lacks the

330 densely crowded spinules on the ventral faces of the labella. In the keys of

331 Borgmeier (1967) *M. salteri* runs to couplet 14, lead 2, on page 93, to *M.*

332 *patellipyga* Borgmeier. However, the latter has strikingly enlarged

333 posterolateral lobes of the epandrium. Apart from *M. tamilnaduensis* (see

334 above) also running to this point *M. abdita* (Brues) and *M. media* (Collin) will

335 also both key out here. Their shorter anal tubes and lack of densely crowded

336 spinules on the ventral faces of their labella distinguish them from *M. salteri*.
 337 The subsequently described *M. alisamorum* Disney will also key out here. It
 338 has densely spinose labella, but its hypopygium has a longer yellow anal tube
 339 and a distinctive elongated and downward curving left lobe of the hypandrium.
 340 *Description.* Male. Head as Fig. 4A, frons brown, clearly broader than long, with
 341 110–120 hairs and dense but very fine microtrichia. Supra-antennal bristles
 342 (SAs) unequal, the lower pair being about 0.8 times as long the upper pair. The
 343 antials clearly lower on frons than anterolaterals and almost as close to eye
 344 margins, but almost midway between upper SAs and AL bristles or a little closer
 345 to USAs. Pre-ocellars closer together than either is from a mediolateral bristle,
 346 which is at about the same level on frons. Cheek with 1–3 bristles and jowl with
 347 two longer. The subglobose postpedicels brown, without subcutaneous pit
 348 sensilla (SPS) vesicles (Fig. 4A, B). Palps (Fig. 4A, B) yellow, about a quarter
 349 as broad as postpedicel but a little longer than breadth of latter, with 4–6 bristles
 350 (the longest, apical, being about two thirds as long as a lower SA bristle) and 5–
 351 6 hairs. Labrum (Fig. 4A) dusky yellow and about three quarters the width of a
 352 postpedicel. Labella coloured as labrum but with darker bands towards sides,
 353 their combined widths about 1.5 times the width of a postpedicel, and with
 354 numerous, densely crowded, short spinules below (Fig. 4B). Thorax brown with
 355 two notopleural bristles and no cleft in front of these. Mesopleuron bare.
 356 Scutellum with an anterior pair of hairs (subequal to those in middle of scutum)
 357 and a posterior pair of bristles. Abdominal tergites brown with hairs longest
 358 towards sides of tergite 2 and at rear of tergite 6 (Fig. 4C). Venter brown, with
 359 hairs on segments 3–6. Epandrium brown, hypandrium only lightly tinged

360 brown and anal tube pale brown (Fig. 4C). Left lobe of hypandrium longer than
 361 right lobe. Apart from brown patch on mid coxa, legs yellowish lightly tinged
 362 brown, except the hind femora browner and getting darker towards tip. Fore
 363 tarsus with posterodorsal hair palisade on segments 1–4 and 5 slightly longer
 364 than 4. Dorsal hair palisade of mid tibia extends about 0.8 times its length.
 365 Hairs below basal half of hind femur clearly longer than those of anteroventral
 366 row of outer half (Fig. 4D). Hind tibia with 8–10 clearly differentiated
 367 posterodorsal hairs and spinules of apical combs simple or occasionally with a
 368 single bifurcated spinule above the posteroventral apical spur. Wings (Fig. 4E)
 369 1.3–1.6 mm long. Costal index 0.34–0.44. Costal ratios 4.2–6.5: 1.8–2.9: 1.
 370 Costal cilia (of section 3) 0.07–0.09 mm long. A small hair at base of vein 3.
 371 With 2 axillary bristles, both being longer than costal cilia (the outer being 0.09–
 372 0.11 mm long). Membrane pale, only slightly tinged gray. Thick veins brown,
 373 except costa pale, thin veins 4–6 more gray and 7 only discernible with critical
 374 lighting. Membrane only very lightly tinged gray (not evident to naked eye when
 375 viewed against a white background). Haltere brown.
 376 Female. Head similar to male but except palp with 6–7 hairs that are longer
 377 than those of male, labrum brown and a little wider than diameter of postpedicel
 378 and labella not enlarged and with at most only 1 or 2 small spinules below.
 379 Abdominal tergites brown. Tergites 3–7, front margin of tergite 6 being as broad
 380 as length. Venter brown, with hairs below segments 3–6. Sternite 7 as Fig. 4G.
 381 Posterolateral lobes at rear of sternum 8 as Fig. 4G. Cerci pale and about 2.6
 382 times as long as broad. Furca and Dufour's crop mechanism not discerned.
 383 Legs similar to male but hind tibia with fewer posterodorsal hairs. Wing as male

1 384 except 1.4_1.7 mm long. Costal index 0.38_0.43. Costal ratios 3.3_6.0: 1.9_3.3:

2
3 385 1. Costal cilia 0.06_0.08mm long. Outer axillary bristle 0.08_0.10mm long.

4
5
6 386 Otherwise it and haltere as male.

7
8
9 387 ***Megaselia stepheni* Disney sp. nov.** (Fig. 5A–G)

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11 388

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13
14 389 *Etymology.* Named for Stephen Salter (see Acknowledgements).

15
16 390 *Type series.* Holotype, male, Ishikawa Prefecture, Kanazawa City, 2–

17
18
19 391 15.vii.2012, ex *Russula violeipes*, N. Tuno (sample 25, MZUC, 34–167).

20
21 392 Paratypes, 3 males, 4 females as holotype except samples 18 & 26, MZUC,

22
23
24 393 and samples 4 & 5, LEKU.

25
26 394 *Diagnosis.* The fifth segment of the mid tarsus being clearly longer than the

27
28
29 395 fourth segment means that in the key to males recorded from the British Isles

30
31 396 (Disney 1989a) this species runs to couplet 12, lead 2, to *M. lutea* (Meigen);

32
33
34 397 but more closely resembles the Japanese *M. gotoi* and an Australasian and an

35
36 398 Oriental species. It is distinguished from these 3 species in the key below.

37
38 399 *Description.* Male. Frons mainly yellow but brown around the sockets of the

39
40
41 400 Supra-antennal bristles (SAs) and ocellar triangle brown, clearly broader than

42
43 401 long, with 40_50 hairs and crowded but very fine microtrichia. Supra-antennal

44
45 402 bristles (SAs) unequal the lower pair being about two thirds the length of the

46
47
48 403 upper pair. The antials slightly lower on frons than anterolaterals, and about

49
50
51 404 twice as far from upper SAs as either from an AL bristle. Pre-ocellars about as

52
53 405 far apart than either from a mediolateral bristle, all four being at about the same

54
55 406 level on frons. Cheek with 3_4 bristles and jowl with 2 longer. The subglobose

56
57
58 407 postpedicels yellow, without subcutaneous pit sensilla (SPS) vesicles (Fig. 5A).

408 Palps (Fig. 5A) yellow, about 6 times as long as broad and 1.2 times as long as
 409 width of postpedicel, with 5_6 bristles (the longest, apical, one about 1.2 times
 410 as long as lower SA bristle) and as many hairs. Labrum (Fig. 5A) yellow about
 411 two thirds as wide as a postpedicel. Labella (Fig. 5A) coloured as palps almost
 412 devoid of short spinules below. Thorax mainly yellow. Three notopleural
 413 bristles and no cleft in front of these. Mesopleuron bare. Scutellum with an
 414 anterior pair of hairs (about as long as those in middle of scutum) and a
 415 posterior pair of bristles. Abdominal tergites 1_3 brown and tergites 4_5 yellow,
 416 with hairs longest at rear of tergite 6 (Fig. 5B). Venter yellow, with hairs on
 417 segments 3_6. Epandrium brown, hypandrium paler and its long left lobe and
 418 very short right lobe pale yellowish; with a pale brown anal tube. Apart from
 419 brown patch on mid coxa, legs yellow. Fore tarsus with posterodorsal hair
 420 palisade on segments 1_5 and 5 just longer than 4. Dorsal hair palisade of mid
 421 tibia extends about two thirds its length and its spur about as long as basitarsus
 422 of mid tarsus. The ratios of the lengths of the mid tarsal segments about 1.4:
 423 0.5: 0.4: 0.2: 1. Hairs below basal half of hind femur longer than those of
 424 anteroventral row of outer half (Fig. 5D). Hind tibia with 16_18 differentiated
 425 posterodorsal hairs and spinules of apical combs simple. Wings (Fig. 5E) 1.5_1.6 mm long. Costal index 0.42_0.45. Costal ratios 3.7_3.8: 1.2_1.7: 1. Costal cilia (of section 3) 0.05_0.06 mm long. No hair at base of vein 3 and the latter a little thickened in basal half. With 2 axillary bristles, both being longer than costal cilia (the outer being 0.10 mm long). Sc not quite reaching R1. All veins brown, except costa pale. Membrane tinged gray (just evident to naked eye when viewed against a white background). Haltere with brownish gray knob.

1 432 Female. Head similar to male but labrum light brown and a little wider than a
2
3 433 postpedicel. Thorax as male. Abdominal tergites yellow apart from tergite 7.
4
5 434 Tergites 5–7 as Fig. 5F. Venter pale dusky yellow, and with hairs below
6
7
8 435 segments 3–6. Sternite 7 brown (Fig. 5G). Posterolateral lobes at rear of
9
10 436 sternum 8 largely represented by a pair of apical bristles (Fig. 5G). Cerci pale
11
12 437 relatively short (Fig. 5G). Furca and Dufour's crop mechanism not discerned.
13
14
15 438 Legs similar to male but last segment of mid tarsus not longer than 3+4, but a
16
17 439 little longer than 4. Wing as male except length 1.7–1.8mm. Costal index 0.49–
18
19 440 0.54. Costal ratios 3.5–4.7: 1.5–2.3: 1. Costal cilia 0.06–0.08mm long. Outer
20
21 441 axillary bristle 0.11–0.12 mm long. Vein 3 not thickened in basal half. Haltere as
22
23 442 male.

24
25
26
27
28 443 **Key to palaearctic species resembling *Megaselia lutea* as their fifth**
29
30 444 **segment of the mid tarsus being clearly longer than the fourth segment**
31
32
33 445 Note: females can only be assigned to this complex by their association with
34
35 446 males.

36
37
38 447

39	448	1	Males.....	2
40	449	-	Females.....	9
41	450			
42	451	2	Mesopleuron with hairs.....	3
43	452	-	Mesopleuron bare.....	5
44	453			

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1	454	3	Epandrium with hairs only. Section 1 of costa not thicker in basal two	
2				
3	455		thirds and section 2 is longer than section 3. Spur of mid tibia clearly	
4				
5	456		shorter than mid basitarsus.....	4
6				
7				
8	457	-	Epandrium with hairs plus 3_4 bristles towards lower margins each	
9				
10	458		side. Costa thicker in basal two thirds of section 1 and section 2	
11				
12	459		shorter than section 3. Spur of mid tibia about as long as mid	
13				
14	460		basitarsus.....	<i>setifurcana</i> Liu
15				
16	461			
17				
18				
19				
20	462	4	Abdominal tergites brown.....	<i>tibisetalis</i> Fang
21				
22	463	-	Abdominal tergites 1_4 brown contrasting with yellow tergites 5–6 (Fig.	
23				
24	464		1B).....	<i>donaldsonae</i> Disney sp. nov.
25				
26	465			
27				
28				
29				
30	466	5	Thorax and postpedicels of antennae yellow.....	6
31				
32	467	-	Thorax and postpedicels of antennae brown. (Hypopygium as fig. 414	
33				
34	468		in Disney 1989a. More than 3 bristles on axillary ridge of wing. Tip of	
35				
36	469		hind femur brown).....	<i>scutellaris</i> (Wood)
37				
38				
39				
40	470		Note: the Australasian <i>M. tetrachaeta</i> Beyer has a light brown thorax and a	
41				
42	471		brown tip to the postpedicel. It differs from <i>M. scutellaris</i> in having the first	
43				
44	472		costal section clearly shorter than sections 2+3 combined and its costal cilia	
45				
46	473		being less than 0.1 mm in length.	
47				
48				
49	474			
50				
51				
52	475	6	With only 2 axillary bristles. Hind femur entirely yellow.....	7
53				
54	476	-	With more than 3 axillary bristles. Tip of hind femur brown.	
55				
56	477		(Hypopygium as fig. 415 in Disney 1989a).....	<i>lutea</i> (Meigen)
57				
58				
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1	478			
2				
3	479	7	Epandrium with hairs above and 1 or more bristles near lateral margins.	
4				
5	480		Abdominal tergites with longer hairs towards lateral margins only on	
6				
7	481		segments 2 and 6. Abdominal venter with smaller hairs on segments	
8				
9	482		3-6. The last segment of the mid tarsus thicker than segment 4, at least	
10				
11	483		basally.....	8
12				
13	484	-	Epandrium with several bristles but lacking hairs dorsally (fig. 2 in Disney	
14				
15	485		1989b). Abdominal tergites 2-6 with long hairs laterally that are clearly	
16				
17	486		differentiated from those above. Abdominal venter with long bristle-like	
18				
19	487		hairs on segments 5 and 6 (fig. 32 in Disney 1989b) but minute hairs only	
20				
21	488		on segments 3 and 4. The last segment of the mid tarsus not thicker than	
22				
23	489		segment 4..... <i>gotoi</i> Disney	
24				
25	490		Note: the Oriental <i>M. termimycana</i> Disney closely resembles <i>M. gotoi</i> but only	
26				
27	491		has short fine hairs on segments 5 and 6 of the venter.	
28				
29	492			
30				
31	493	8	Epandrium with a single bristle each side (Fig. 2B). Segment 5 of mid	
32				
33	494		tarsus shorter than segments 3 and 4 combined (Fig. 2C)	
34				
35	495	 <i>margaretae</i> Disney sp. nov.	
36				
37	496	-	Epandrium with 2 bristles each side (Fig. 5B). Segment 5 of mid tarsus	
38				
39	497		longer than segments 3 and 4 combined (Fig. 5C)..... <i>stepheni</i>	
40				
41	498			Disney sp. nov.
42				
43	499			
44				
45	500	9	Mesopleuron with hairs.....	10
46				
47	501	-	Mesopleuron bare.....	12
48				
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1	502			
2				
3	503	10	Abdominal tergite 6 at least as long as width on anterior margin (e. g.	
4			Fig.1E). Costal section 2 longer than section 3.....	11
5	504			
6				
7				
8	505	-	Tergite 6 clearly wider than its length. Costal section 2 shorter than	
9			section 3.....	<i>setifurcana</i> Liu
10	506			
11				
12	507			
13				
14				
15	508	11	Abdominal tergites brown and tergite 6 tapered towards hind	
16			margin.....	<i>tibisetalis</i> Fang
17	509			
18				
19				
20	510	-	Abdominal tergites yellow and tergite 6 more-or-less rectangular.....	
21				
22				
23	511		<i>donaldsonae</i> Disney sp. nov.
24				
25	512	12	Thorax and postpedicels of antennae yellow.....	13
26				
27	513	-	Thorax and postpedicels of antennae brown. (More than 3 bristles on	
28			axillary ridge of wing. Tip of hind femur brown. Rear of abdomen as	
29	514			
30			Fig. 7).....	<i>scutellaris</i> (Wood)
31	515			
32				
33				
34				
35	516		Note: the unknown female of the Australasian <i>M. tetrachaeta</i> Beyer will have a	
36			light brown thorax and a brown tip to the postpedicel, It will differ from <i>M.</i>	
37	517			
38			<i>scutellaris</i> in having the first costal section clearly shorter than sections 2+3	
39	518			
40			combined and its costal cilia being less than 0.1mm in length.	
41	519			
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44	520			
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46				
47	521	13	Wing with only 2 axillary bristles. Hind femur entirely yellow.....	14
48				
49	522	-	With more than 3 axillary bristles. Tip of hind femur brown. (Abdominal	
50			tergites entirely brown and as Fig. 6).....	<i>lutea</i> (Meigen)
51	523			
52				
53	524			
54				
55				
56				
57	525	14	Abdominal tergites yellow.....	15
58				
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1 526 - Abdominal tergites 2-5 yellow in anterior halves or more and brown
2
3 527 behind and tergite 6 almost as long as width of anterior margin (Fig.
4
5
6 528 2G).....*margaretae* Disney sp. nov.
7
8 529 Note: the Oriental *M. termimycana* Disney closely resembles *M. margaretae* but
9
10 530 has uniformly brown abdominal tergites and tergite 7 narrows in its anterior half
11
12
13 531 (fig. 4 in Disney & Chou 1996).
14
15
16 532
17
18 533 15 Tergite 6 clearly broader than long (Fig. 5F). Anterolateral bristles at
19
20 534 about the same level on frons as upper supra-antennal
21
22
23 535 bristles.....*stepheni* Disney sp. nov.
24
25 536 - Length of tergite 6 almost equal to width of front margin. AL bristles
26
27 537 higher on frons than upper SAs..... *gotoi* Disney
28
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30 538
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35
36 540 **Discussion**
37
38 541 The Phoridae is among the commonest families of flies reported emerging from
39
40 542 fungus sporophores. Phorids have been recorded from younger sporophores
41
42
43 543 than the family Drosophilidae, which are more characteristic of mature to
44
45 544 decaying stages (Tuno N pers. obs.). In our rearings from various species of
46
47
48 545 sporophores sampled in Ishikawa Prefecture we obtained eight *Megaselia*
49
50 546 species including five species new to science. Among the new species, *M.*
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52
53 547 *salteri* sp. nov. and *M. stepheni* sp. nov. showed narrow host preference. The
54
55 548 latter emerged from species of *Russula* (Russulaceae) and the former from
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57
58 549 species of *Gymnopilus* (a genus formerly assigned to Cortinariaceae but
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currently unplaced in the present fungal classification). Compared with dominating species like *M. flava*, these minor species in number showed proportionally narrower host preferences. Some ecologists have explored the general pattern in the relationships between fungal host and fungivorous flies using mycophagous drosophilid flies, a taxonomically well studied group (Lacy 1984; Takahashi *et al.* 2005; Toda *et al.* 1999; Tuno 2001). In the Drosophilidae, most of the dominating species utilize a wide range of host mushrooms. It is apparent that we are far from a comprehensive understanding of the species diversity in mycophagous flies in Japan. It has been proposed that mycophagous flies are generalists in terms of host selection but this has been observed in only for dominating fly species and most of unnamed flies have been omitted from ecological studies. We may need to review ecological hypothesis and theories that have been proposed on the basis of such biased datasets on fungal host ranges for most of the unnamed mycophagous flies. The proportion of new species of scuttle flies underlines the perception that Phoridae associated with fungi in Japan is still a largely unexplored field. Future studies can be expected to add many more new phorid species and new fungus host records for known species. Those for Phoridae associated with fungi in Japan are likely to contribute to a more comprehensive understanding of the relationships between fungal host and their consumers and the diversity of the group in terms of ecological functions.

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Captions for figures for paper on **New records of scuttle flies (Diptera: Phoridae) reared from fungus sporophores in Japan, including five new species**

Figure 1. *Megaselia donaldsonae* sp. nov., male (A-D) and female (E, F). (A) dorsal (frontal) view of anterior (lower) part of head; (B) left face of hypopygium; (C) mid tarsus; (D) right wing; (E) abdominal tergites 5 and 6 (anterior end to right); (F) abdominal sternite 7 (anterior end to right).

Figure 2. *Megaselia margaretae* sp. nov., male (A-E) and female (F-H). (A) antennae, palps and proboscis from above; (B) left face of hypopygium; (C) mid tarsus; (D) hind femur; (E) right wing; (F) dorsal (frontal) view of anterior (lower) part of head; (G) dorsal face of abdomen from tergite 5 onwards; (H) abdominal sternite 7 and tips of lobes at rear of sternum 8 (anterior end to left).

Figure 3. *Megaselia nakayamai* sp. nov., male (A-C). (A) left antenna and palp from above; (B) left face of hypopygium; (C) right wing.

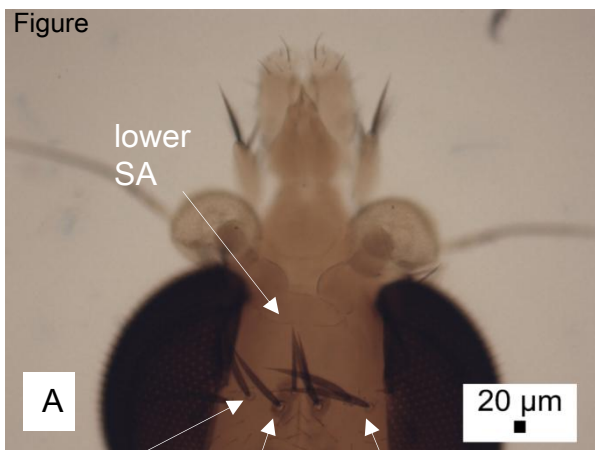
Figure 4. *Megaselia salteri* sp. nov., male (A-E) and female (F, G). (A) frontal view of head; (B) proboscis, palps and antennae, but focused down to ventral view of labella; (C) left face of hypopygium; (D) hind femur; (E) right wing; (F) abdominal tergites 3-7; (G) abdominal sternite 7 and tips of lobes at rear of sternum 8.

Figure 5. *Megaselia stepheni* sp. nov., male (A-E) and female (F, G). (A) proboscis and right palp and antenna; (B) left face of hypopygium; (C) mid tarsus; (D) hind femur; (E) right wing; (F) abdominal tergites 5 -7; (G) sternite 7 to tip of abdomen.

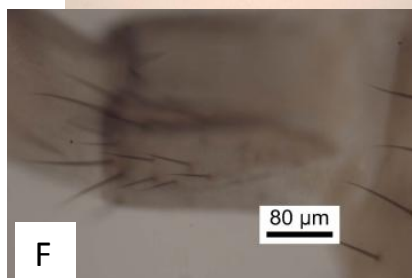
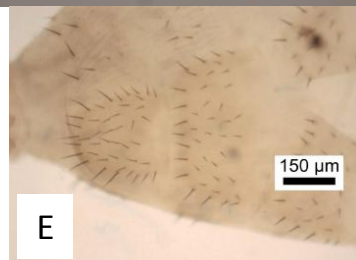
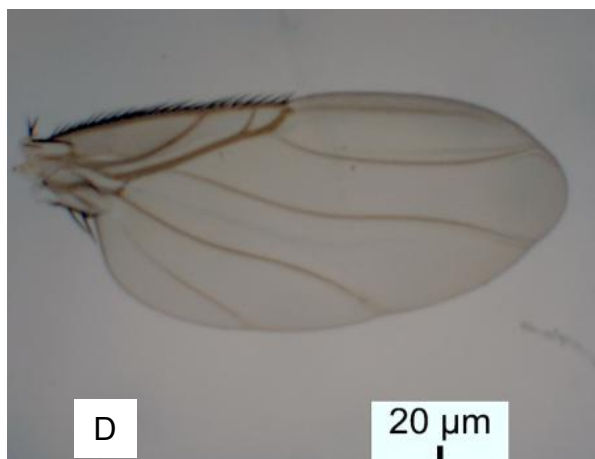
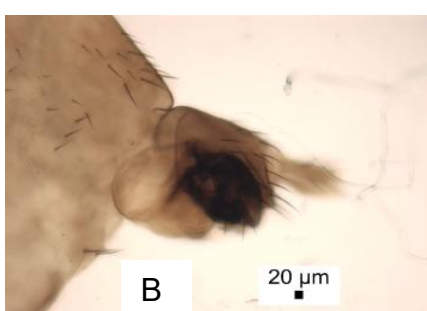
Figure 6. *Megaselia lutea* female, abdominal tergite 5 to tip of abdomen.

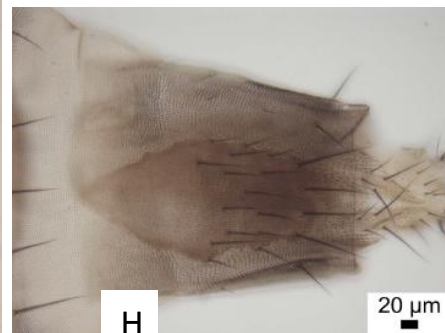
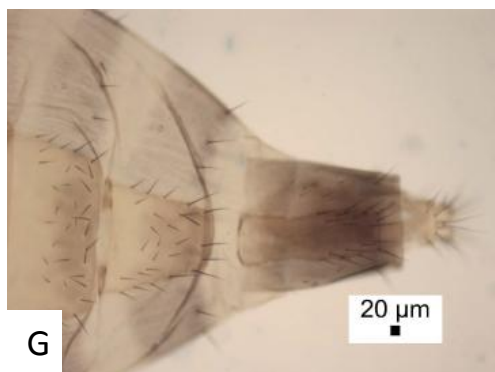
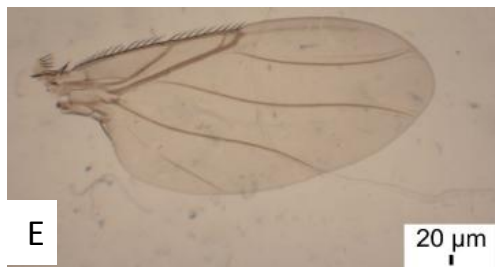
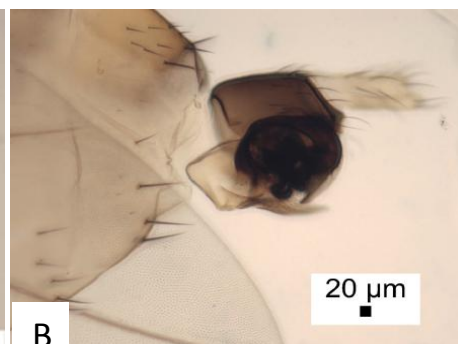
Figure 7. *Megaselia scutellaris* female, abdominal tergite 5 to tip of abdomen.

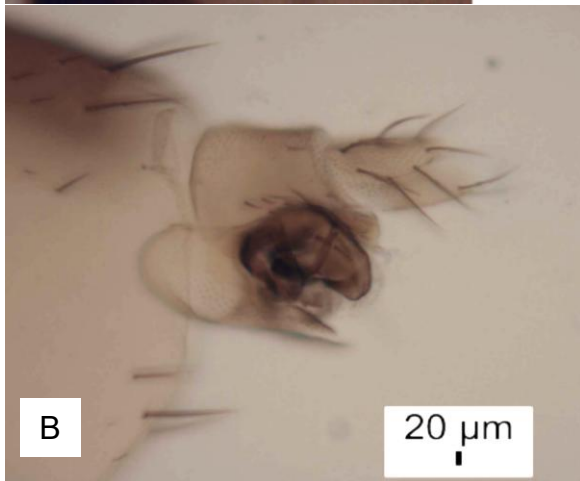
Figure

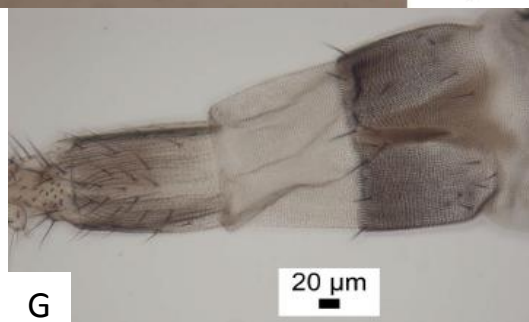
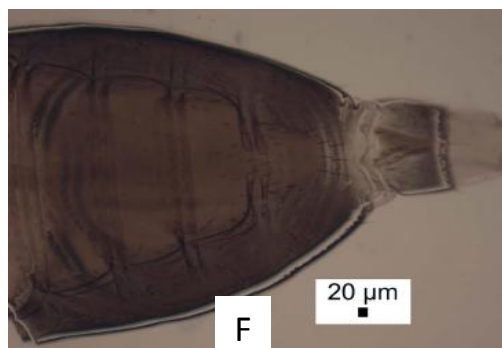
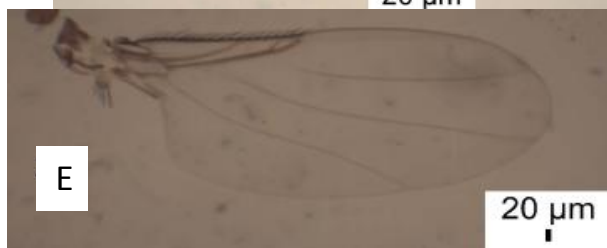
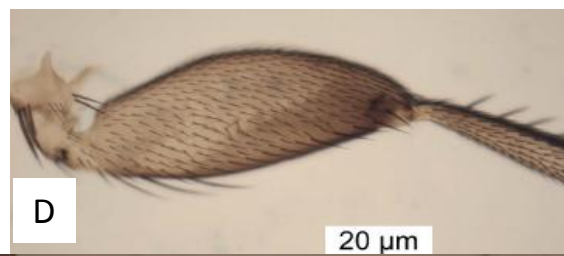
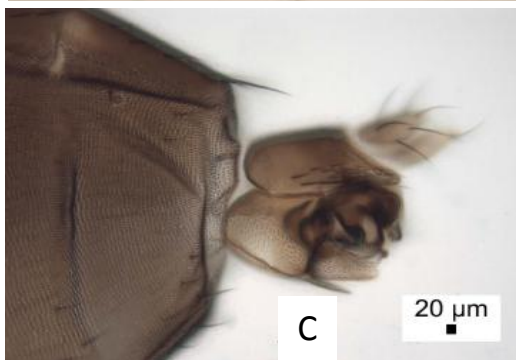


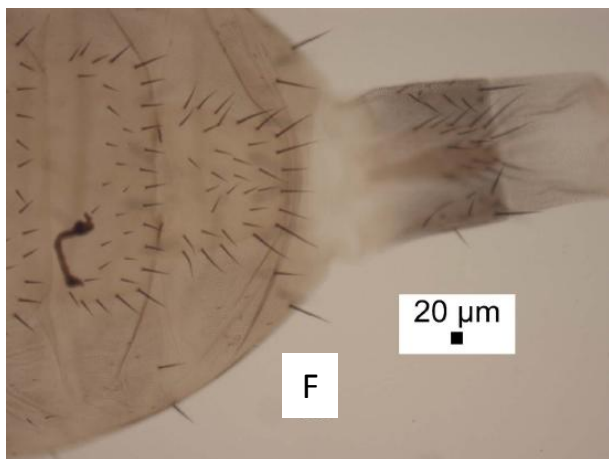
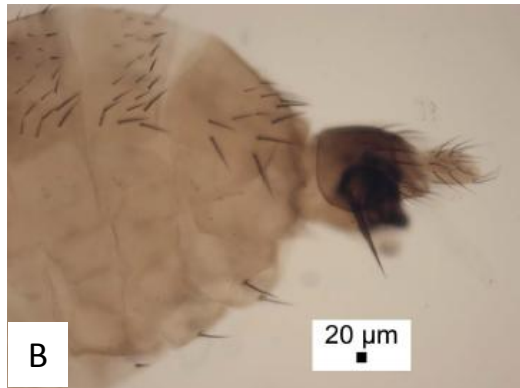
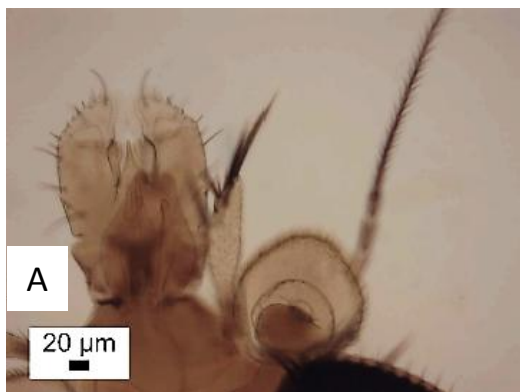
antial (A) upper supra-antennal (SA) antero-lateral (AL)

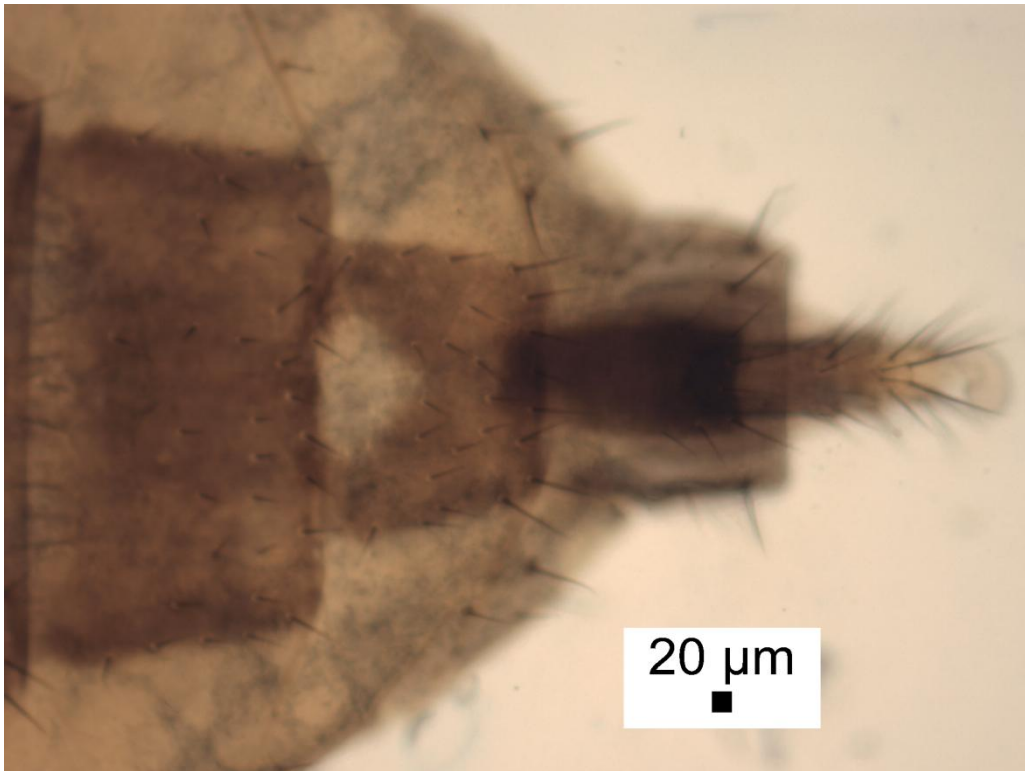


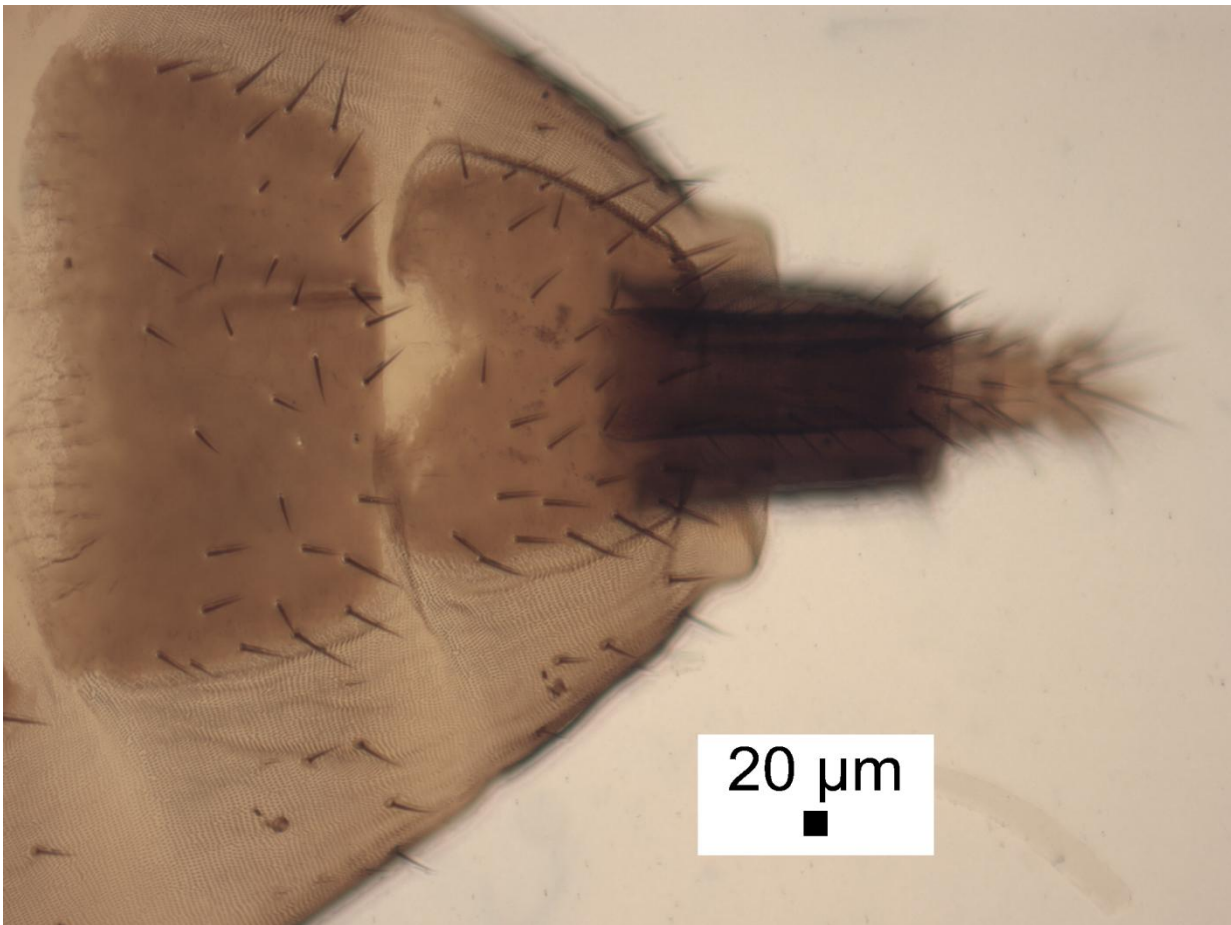












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